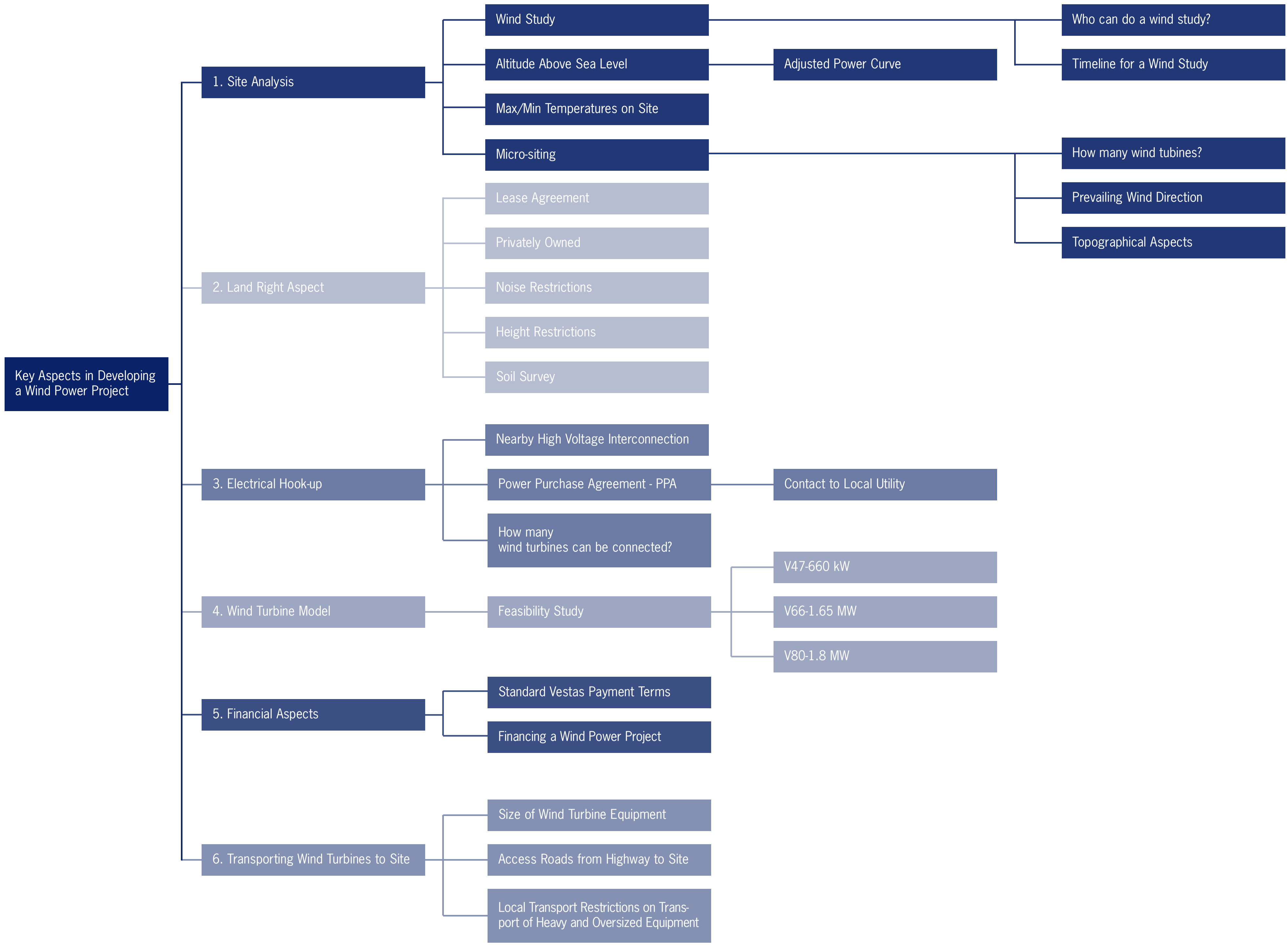
# Key Aspects in Developing a Wind Power Project



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# 1 Site Analysis

## 1.1 Wind Study

Energy production depends on the wind speed potential at the proposed site. The best way to determine the wind speed at a specific site is by erecting one or more anemometer masts, which will measure the wind speed at the site for at least 12 months.
If a good, solid wind study is performed upfront, the feasibility study will be much more accurate, and therefore valuable.

As the energy in the wind increases exponentially with the wind speed, only small deviations in the wind resource assumption can significantly affect the overall economy of the wind power project.

Furthermore we have also experienced that financial institutions generally require wind study documentation from an independent specialist prior to closing a finance agreement.

### 1.1.1 Who can do a wind study?

As the wind power industry has grown over the years, so has the wind survey industry. Although Vestas does not do wind studies, we can put you in contact with wind measurement institutions who may already have wind data for your region – or with independent specialists who could perform a wind study of your site.

Another option is to team up with an experienced wind power developer and let them help you develop your site. The American Wind Energy Association's home page (www.awea.org) lists all American wind energy developers.

For projects on sites with hills and mountain ridges, Vestas suggest that you team up with professional micro-siting consultants at an early stage of project development. The wind-flow over such sites can be very complex, thereby affecting the energy production and lifetime of such projects significantly.

### 1.1.2 Timeline for Wind Study

To estimate the production potential of a specific site, it is essential to have as much wind data as possible. The longer the duration of the wind study, the more accurate the production estimates will be.

Since there are typical "windy seasons", where the wind blows at a substantially higher speed than the rest of the year, a full year of wind data is preferred.

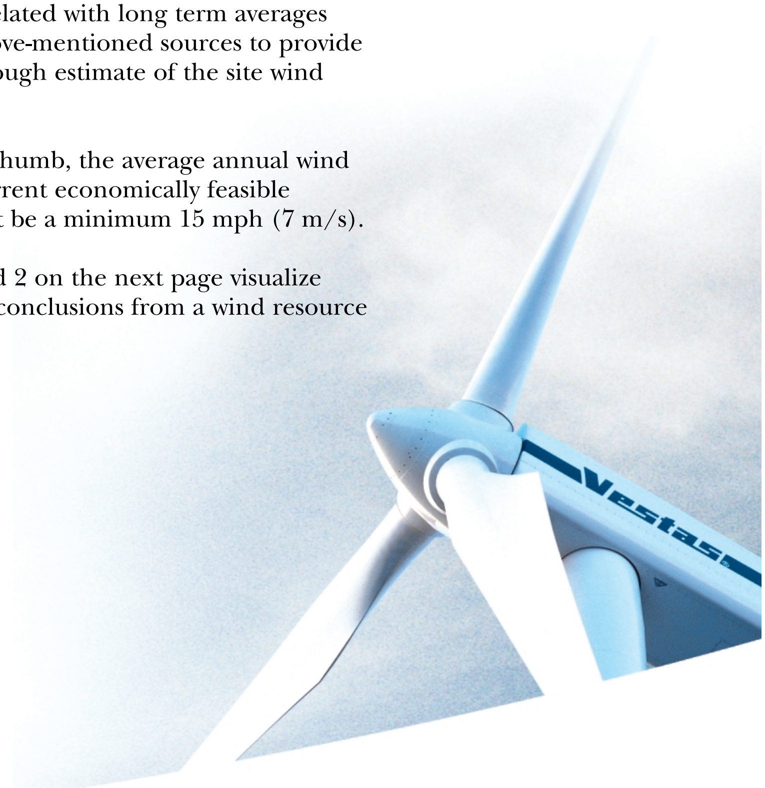
For an indication of the wind potential in a region, you might contact the local airport or weather bureau, which could provide you with the mean average wind speed for that area.

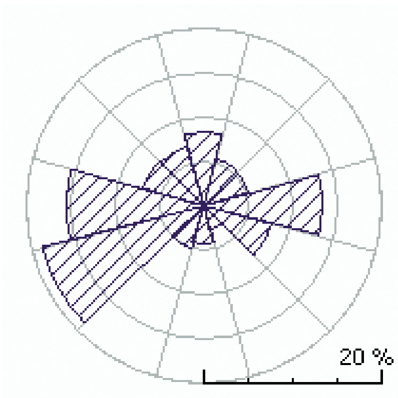
However, in order to achieve a reasonable accuracy, the distance from the measurement location to the potential wind farm site must be less than 15 miles.

Site specific wind measurements can be further correlated with long term averages from the above-mentioned sources to provide a more thorough estimate of the site wind data.

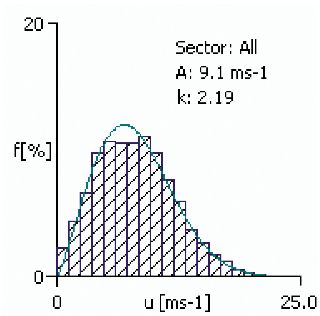
As a rule of thumb, the average annual wind speed on current economically feasible projects must be a minimum 15 mph (7 m/s).

Graphs 1 and 2 on the next page visualize some of the conclusions from a wind resource assessment.






*__Graph 1: Wind direction distribution curve.__ This curve indicates the prevailing wind direction. In this situation, the prevailing wind directions are West and Southwest. This graph indicates that the turbines should be placed at lines perpendicular to the Southwest winds. However local topographic issues must also be considered.*




***Graph.2: Wind speed distribution curve.***
*This curve indicates the frequency of a particular wind speed over a certain measurement period. The horizontal axis shows the wind speed (m/s or mph), while the vertical axis indicates the frequency of these wind speeds. This curve indicates that the most frequent wind speed on this site is 9.1 meters/second (20.4 mph). Furthermore, the K-factor describes the shape of the curve. With this data it is possible to make a good production estimate of a turbine placed at the same location as this anemometer mast.*

## 1.2 Altitude Above Sea Level

It is well known that the air density decreases as the air becomes thinner when we climb up a mountain. The energy produced by a wind turbine is directly dependent on air density. Therefore a wind turbine placed on a mountain with an average mean wind speed of 17 mph will produce less energy than the same turbine placed at sea level with the same mean wind speed.

For this reason, it is important to determine the height above sea level and the average air density at the potential site as part of the initial investigation.

The standard power curves are adjusted to standard air density at sea level at 68° F. For power curve adjustments at various air densities, please refer to the General Specification of the turbine.

## 1.3 Maximum and Minimum Temperatures on Site

The standard Vestas turbine operates in an ambient temperature range of -4° to 104° F (-20° to 40° C). When the temperature exceeds these limits, the turbine will automatically ramp down the production to a PAUSE-mode. When the temperature returns within these ranges, the turbine will automatically restart production. On some wind turbine models it is possible to extend the temperature range to -22° to +113° F (-30° to +45° C)

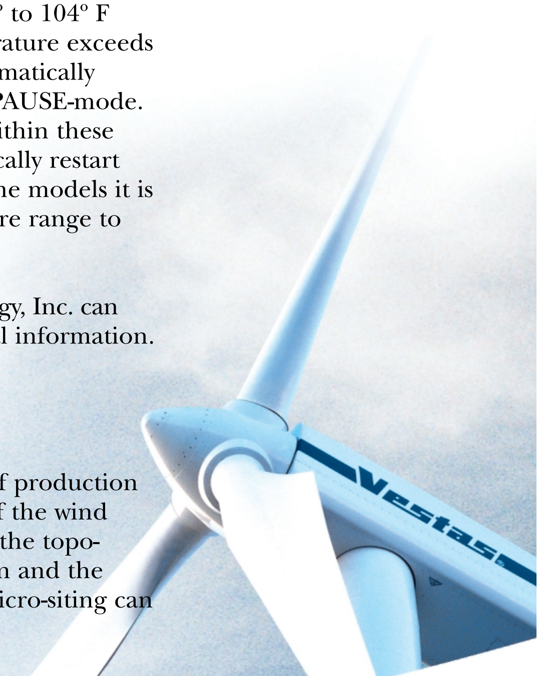
Vestas – American Wind Technology, Inc. can provide you with further technical information.

## 1.4 Micro-siting

Micro-siting is the optimization of production through the correct placement of the wind turbines in the landscape. When the topographical data of the site is known and the wind data collected, the actual micro-siting can begin.

Where one major wind direction prevails, it is normally optimal to place the turbines on rows perpendicular to the prevailing wind direction. In other situations it might be more efficient to place the turbines according to some topographical aspects. In this case roughness of terrain, proximity to trees, houses and other obstacles will be taken into consideration.

Vestas can provide some initial micro-siting suggestions, based on wind and topographical data. However, Vestas recommends that a third party evaluate the micro-siting aspects prior to establishing the final site layout.



## 2. Permitting

Early in project development, it is important to determine the legal aspects of building a wind farm on a certain site. It is important to pay attention to whether there are restrictions on such things as heights, noise levels or minimum distances to buildings.

## 3. Electrical Hook-up

Vestas wind turbines have to be connected to the existing grid at all times. The turbines cannot be installed as 'Stand alone' systems.

In the early stages of project development, it is important to determine the distance to the nearest High Voltage grid to which the wind turbines can be connected. The farther away the existing High Voltage grid is, the more expensive the project will be.

The output voltage of the V47-660 kW is 690 V. A pad-mounted transformer will adjust the output voltage to fit the local voltage level of the interconnection point.

The V66-1.65 MW and the V80-1.8 MW have a pre-installed step up transformer in the nacelle. This transformer will be customized to fit the local voltage requirements to a maximum of 33 kV.

For a project not being developed by a utility, it is wise to make early contact with the local utility to negotiate a Power Purchase Agreement (the PPA).

## 4. Turbine Technology

Vestas has over 20 years of experience in the development and production of wind turbines. There are more than 12,000 Vestas wind turbines installed worldwide. The sizes of these machines vary from the early 55 kW to the newest 2.0 MW machines.

Based on the extensive experience gained from these machines and the technological advances over the years, the product line of Vestas – American Wind Technology, Inc. represents a strong fleet:

1. V47-660 kW 'the smallest'
2. V66-1.65 MW 'the bigger one'
3. V80-1.8 MW 'the biggest'

Each model has its own advantages. Vestas together with the client can determine which turbine model is best suited to fulfill the requirements of the specific wind power project, based on a feasibility study.

## 5. Financial Aspects

### 5.1 Standard Vestas Payment Terms

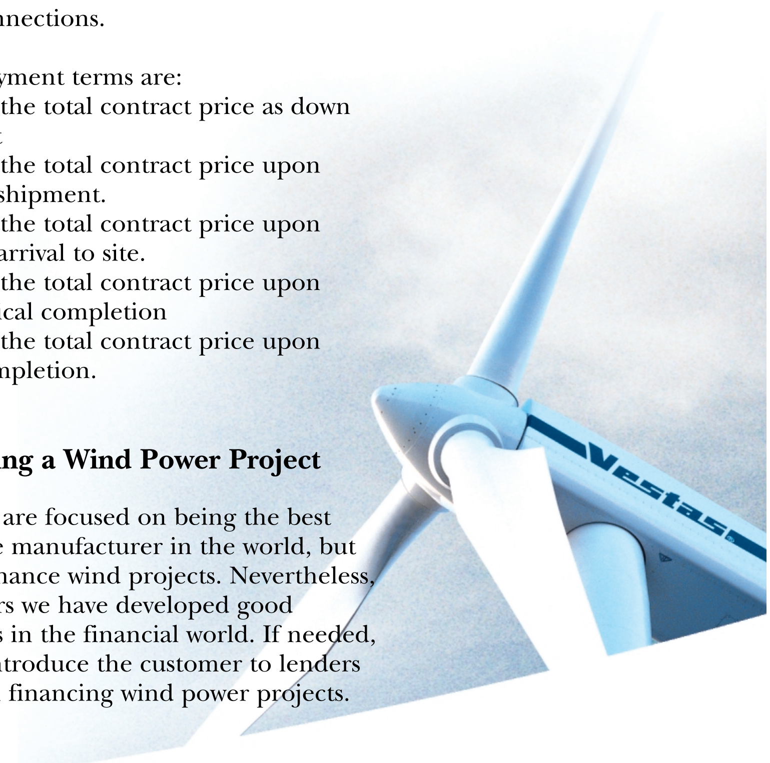
It is company policy at Vestas that payment security be established as a condition to the sales agreement. This is normally arranged by a Letter of Credit from the Client's or Vestas' financial connections.

Standard payment terms are:

- 20 % of the total contract price as down payment
- 50 % of the total contract price upon turbine shipment.
- 10 % of the total contract price upon turbine arrival to site.
- 10 % of the total contract price upon mechanical completion
- 10 % of the total contract price upon final completion.

### 5.2 Financing a Wind Power Project

At Vestas we are focused on being the best wind turbine manufacturer in the world, but we do not finance wind projects. Nevertheless, over the years we have developed good relationships in the financial world. If needed, Vestas can introduce the customer to lenders interested in financing wind power projects.



# 6. Transporting the Wind Turbine to Site

As listed in the General Specification of the turbine, the size and the weight of a modern wind turbine require special transportation equipment.

Over the years Vestas has developed expertise in transporting these oversized items. Vestas has transported and installed turbines at locations where it was previously considered impossible to perform this type of installation. Still, there are limits!

Early in the project, it is vital that the developer and Vestas together evaluate the likelihood and price impact of transporting these oversized items to the proposed site.

To illustrate the complexity of modern wind turbine transportation, we show pictures from a transport sequence of a V66-1.65 MW wind turbine.


*V66 nacelle transport in a narrow intersection.*

*V66 tower section transport in a narrow uphill turn.*

*V66 nacelle transport with an extra tow-truck underway to site.*

*V66 (105 ft-long) blade container on an expandable trailer takes a narrow corner in a small village.*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